

CHILEAN SPECIES OF THE GENUS *EUPSOPHUS* (ANURA : LEPTODACTYLIDAE)

By ALICE G. C. GRANDISON

EUPSOPHUS Fitzinger, 1843, *Syst. Reptilium*, p. 31

Type species *Cystignathus roseus* Duméril & Bibron

THE name *Eupsophus* was pointed out by Parker (1932) to be an available generic name for the species formerly assigned to *Borborocoetes* Bell, the latter name being preoccupied. Boulenger (1882) in his key to the genus *Borborocoetes* divided the component species into two groups according to the presence or absence of a tympanum. Three species, all occurring in Chile, *calcaratus*, *maculatus* and *coppingeri*, were included under the heading of "no tympanum" and he recognized ten Chilean species, one of which was tentatively referred to the genus. As currently classified (Nieden, 1923) the genus is divided into eleven species, six of which occur in Chile. These six species with their ranges are given by Nieden as :

<i>E. grayi</i> (Bell)	Chile.
<i>E. masareyi</i> (Roux)	Coronel (Chile).
<i>E. roseus</i> (Duméril & Bibron)	Chile to Ecuador.
<i>E. taeniatus</i> (Girard)	Chile.
<i>E. calcaratus</i> (Günther)	Chiloé I., Chile.
<i>E. coppingeri</i> (Günther)	West coast of Patagonia.

The changes that he proposed involved placing *E. maculatus* (Günther) and *E. bibroni* Bell in the synonymy of *E. grayi* (Bell) and *E. nodosus* (Duméril & Bibron) in the synonymy of *E. roseus* (Duméril & Bibron).

The primary division of the key that he devised for the genus was again based on the "presence" or "absence" of a tympanum but only *calcaratus* and *coppingeri* were said to lack the structure. Although Nieden considered *maculatus* to be conspecific with *grayi* he did not report on the condition of the middle ear in these species nor did he give his reasons for believing them to be synonymous.

Ambiguous and misleading terminology such as tympanum hidden, tympanum invisible and tympanum indistinct were a common fault of early descriptions and keys and led workers to assume that the structure is present beneath the skin and that only externally are the tympanum and tympanic annulus invisible. Even as recently as 1959, Schmidt & Inger remark on the inadequacy of the term "tympanum hidden" and have found by dissection that in species described as having a hidden tympanum some lack the tympanum and associated structures while others possess a complete ear apparatus, although external signs are concealed by a covering of thick skin. Boulenger used the term "no tympanic disk", which being a more

precise statement suggested that the three species of *Eupsophus* mentioned above do in fact lack the structure but an examination of the type specimens concerned revealed that the skin covering the ear region had not at any time been reflected in any of the specimens and it was obvious that Boulenger had not checked this character. It was therefore considered advisable by the writer to investigate the condition of the middle ear of all the Chilean species of *Eupsophus* and to present a comprehensive and critical revision of the group.

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The following abbreviations are used :

A.M.N.H.	American Museum of Natural History, New York.
B.M.	British Museum (Natural History), London.
C.N.H.M.	Chicago Natural History Museum.
M.C.Z.	Museum of Comparative Zoology, Harvard College, Cambridge.
M.H.N.P.	Muséum National d'Histoire Naturelle, Paris.
N.H.M.V.	Naturhistorisches Museum, Vienna.
R.N.H.L.	Rijksmuseum van Natuurlijke Historie, Leiden.
R.S.E.	Royal Society Expedition to Southern Chile.
U.B.	University of Bergen.
Z.I.L.U.	Zoologiska Institution Lunds Universitets.
Z.M.B.	Zoologisches Museum, Berlin.

METHODS AND TERMINOLOGY

During the course of this study 473 alcohol-preserved specimens and one skeleton were examined and for each species young, half-grown and adult examples of both

sexes were available. Sexual maturity was determined in males by the presence of secondary sex characters and in females by the presence of a thickened, strongly convoluted oviduct or mature ovarian eggs. In a number of individuals an examination of histological sections of the testis was the means for determining the height of sperm activity and the order in which the secondary sex characters developed and regressed. The drawings of the pectoral girdle were based partly on gross anatomy and partly on stained serial sections of the epicoracoid and sternal region.

Critical measurements were made by dial calipers reading to 0.1 mm. and were as follows :

Length of body (total length) : tip of snout to tip of urostyle.

Head length : the distance from the tip of snout to the posterior rim of the tympanum. In those species having no visible tympanum the head length was taken from the tip of the snout to the jaw articulation.

Head width : the greatest width of the head, usually at the position of the tympani.

Length of tibia : the distance from the convex surface of the knee to the tibio-tarsal joint, the measurement being taken with the leg in the flexed position.

Length of foot : the distance from the tip of the fourth toe to the proximal edge of the inner metatarsal tubercle.

Interorbital space : essentially the width of the frontoparietals between the orbits.

Muscle terminology is that of Gaup (1896).

Eupsophus coppingeri (Günther)

(Text-figs. 1-5 ; Pls. 1 and 6)

Cacotus coppingeri Günther, 1881, p. 19 (type locality, Port Rio Frio, west coast of Patagonia).
Borborocoetes coppingeri Boulenger, 1882, p. 257, pl. 17, fig. 2.

MATERIAL EXAMINED

CHILE :

Llanquihue Province : Casa Pangué, 1,000 ft. (frontier station below the Perez Rosales Pass, wet forest), B.M. 1927.5.7.6-8 ; Peulla, south shore of Lake Todos Los Santos (wet forest), B.M. 1927.5.7.75.

Malleco : Cordilleras de Pemehue, C.N.H.M. 48546-48550 ; Cabreria 800 m., Nahuelbuta, Angol, C.N.H.M. 44210-44214, 44216-44219 ; Nahuelbuta, Angol, C.N.H.M. 40132 (6 exs.).

Magallanes : Termas de Tolhuaca, 3,500 ft., C.N.H.M. 6256 ; Puerto Edén, east side of Wellington Island, A.M.N.H. 52884 ; Puerto Rio Frio, east side of Wellington Island, west coast of Patagonia, B.M. 80.7.28.14 (1947.2.19.97) (type of *Cacotus coppingeri*) ; Peninsula Muñoz Gamero 100 m., R.S.E. (1 ex.) ; plateau below S. Peak, Puerto Edén, 2,100 ft. R.S.E. (1 ex.).

ARGENTINE :

Rio Negro : Bariloche, south shore of Lake Nahuel Huapi, B.M. 1958.1.3.97-98, A.M.N.H. 23943-4, Z.M.B. 29470, N.H.M.V. 4670.1-8, N.H.M.V. 2278 (skeleton ♀), N.H.M.V. no register number (1 ex.); San Martin de Los Andes, N.H.M.V. no register number (3 exs.).

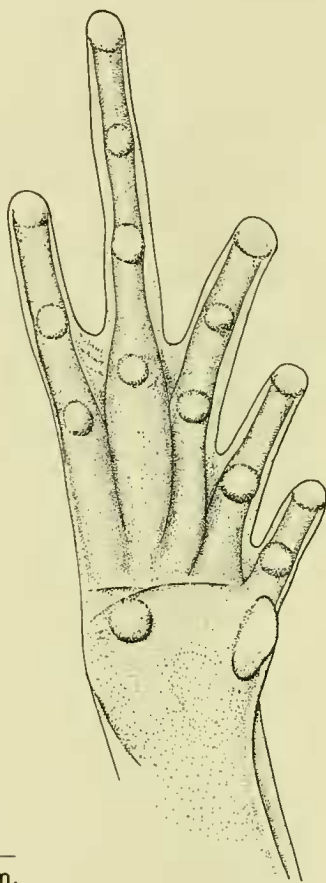


FIG. 1. *E. coppingeri*, C.N.H.M. 48548. Ventral view of the foot. ($\times 17.5$.)

DIAGNOSIS. A large toad-like species (adult females 47-60 mm.; adult males 42-54 mm.), thick set, stocky build, with short, blunt snout; head as broad as, or slightly broader than long; vomerine teeth in two, long, strong, widely separated, posteriorly converging arcs between the choanae; first finger not longer than second; toes $\frac{1}{3}$ to $\frac{1}{4}$ webbed, fringed and flattened; subarticular tubercles prominent

and conical; strong tarsal fold; skin of adults pitted, glandular and sometimes with low, glandular swellings; no middle ear; mature males with large nuptial pads on first and second fingers bearing conspicuous horny spines, also round patches of asperities on each side of chest; no vocal sacs.

DESCRIPTION. Adult female, Cabreria 800 m., Nahuelbuta, Angol, C.N.H.M. 44219. Habitus stocky. Tongue broadly rounded, its posterior half free and with

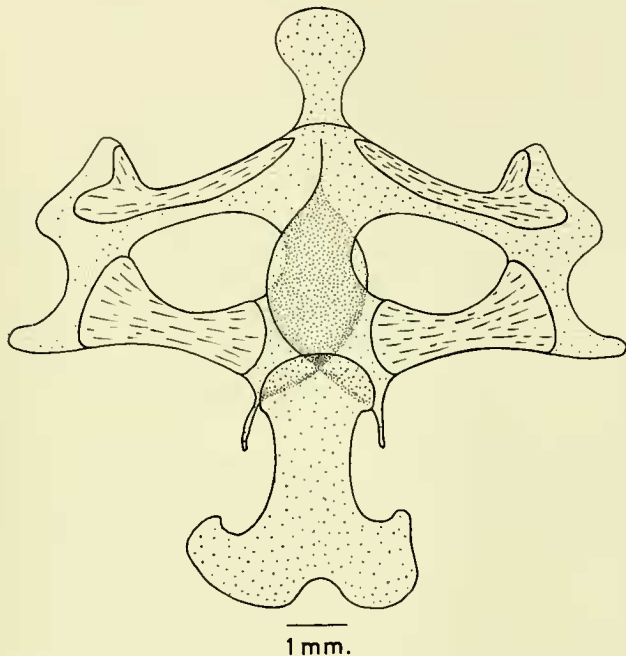


FIG. 2. *E. coppingeri*, B.M. 1958.1.3.97. Ventral elements of the shoulder girdle. ($\times 17.5$)

only a faint indication of a notch; a very narrow seam forming a frill round the edge of the tongue. Vomerine teeth in two very strong, only slightly oblique groups close to inner edges of anterior borders of the semicircular choanae and widely separated from each other by a distance equal to $1\frac{1}{2}$ times the width of one of the choanae. Snout short, rounded in dorsal view, $\frac{2}{3}$ the horizontal diameter of the eye, rounded rather than truncate in profile, the upper jaw extending a little beyond lower jaw. Nares more lateral than dorsal, slightly projecting, the distance between the middle of the nares equal to the interorbital space which is as broad as the upper eyelid, their distance from the anterior borders of the eyes almost twice their distance from the tip of the snout. Canthus rostralis curved but rather indistinct;

loreal region flat and oblique, upper lip flaring out only slightly below; eye large and prominent, scarcely projecting beyond the jaws in dorsal view. Tympanum, tympanic annulus, cavum tympani and columella stapes absent; eustachian tubes reduced to minute foramina. Well-developed glandular fold from behind the eye to the insertion of the arm; at right angles to this fold and continuing laterally and ventrally a pronounced skin fold which passes on to the chest on a level with the clavicles, divided from its fellow by a space equal to the distance between the nares. Omosternum cartilaginous, very short stem and strongly dilated tip; sternum cartilaginous, $2\frac{1}{4}$ times the length of the omosternum, of moderate width medially, broadly expanded posteriorly, deeply emarginate, a reversed broad epsilon in shape, only very slightly shorter than epicoracoids. Tibio-tarsal articulation of the adpressed hind limb reaches to the posterior border of the eye. Limbs sturdy, fingers free of web, first finger shorter than second, subarticular tubercles prominent, supernumerary palmar tubercles present. Tips of fingers and toes rounded, with simple terminal phalanges. Length of foot approximately $1\frac{1}{2}$ times length of tibia. Toes with reduced webbing, the following number of phalanges on the different toes free from web:

1st toe (external surface)	2
2nd toe (external surface)	2
3rd toe (external surface)	$2\frac{2}{3}$
4th toe (external surface)	$3\frac{2}{3}$
5th toe (internal surface)	2

Webbing continued along both edges of the rather flattened toes as a narrow membrane and connecting with a prominent light-coloured tarsal ridge. A large elongate inner, and a small, rounded outer metatarsal tubercle; supernumerary metatarsal tubercles absent; subarticular tubercles well developed and conical. Skin on upper parts of body pitted, thick and glandular, with small, glandular tubercles behind the eye and at the corners of the mouth; ventral surface smooth, except for a granular area around the vent and on the inside of the thighs; limbs smooth. Dorsum with dark interorbital area, continuing posteriorly in an indistinct hour-glass pattern; vertebral stripe apparent only on posterior third of the body; hind limbs cross barred; venter immaculate, dark cream in alcohol.

Measurements:

Length of body	. 59.4 mm.
Length of tibia	. 27.5 mm.
Length of foot	. 31.2 mm.
Length of head	. 20.0 mm.
Width of head	. 24.3 mm.

AUDITORY REGION. On reflecting the skin covering the temporal region of some of the examples of this species, it was noticed that the underlying soft parts in the area bounded anteriorly by the *m. masseter major* and posteriorly by the squamosal arm of the *m. depressor mandibulae*, had been invaded by metacercariae of a

strizeid trematode. As is usual with this kind of trematode, which confines itself to one area, the metacercariae were not found elsewhere in the body.

In this species the *m. depressor mandibulae* is large and firm and has a double origin, the posterior one in the dorsal fasciae overlying the *m. dorsalis scapulae* and towards the upper edge of the suprascapula, and the anterior arm on the dorsolateral surface of the crista parotica. On severing this muscle from its attachment areas and after removal of the epithelial mass, the large triangular-shaped body of the thymus gland is revealed; it lies in the usual anuran position external to the *m. cucullaris* and in the space between the inferior arm of the squamosal and the *m. dorsalis scapulae*. Removal of the *m. cucullaris* and the underlying muscle bands of the petrohyoideus from their origin on the ventral portion of the crista parotica reveals the oval, cartilaginous operculum which, with the small eustachian tubes, are the only elements of the middle ear that are present in this species. The operculum is partly overlain by the *m. levator scapulae superior* which has a broad origin of more or less the width of the plug. There is no trace of calcification of the operculum and there is no superior slip to the "opercular" muscle originating on the auditory capsule behind and internal to the operculum.

VARIATION. The vomerine teeth are between the anterior halves of the choanae in all but two individuals, a half-grown male and a sexually mature female, which have the teeth more posteriorly placed and projecting beyond the posterior borders of the choanae. While the groups of teeth are usually separated posteriorly by a space at least as broad as one of the choanae, in one half-grown individual the groups are contiguous.

Ontogenetic change in head proportions occurs, the head of young individuals (total length less than 30 mm.) being as broad as long and becoming distinctly broader than long with increasing age. Foot length as a proportion of body size varies from 0.43-0.57 ($M = 0.49$; $N = 41$); length of tibia as a proportion of body size is 0.38-0.48 ($M = 0.43$; $N = 40$).

Differences in skin texture do not appear to be correlated with sex or age although there is a tendency for young specimens to have a more warty skin and older examples of both sexes, from throughout the known range of the species, have a thick, glandular, porous skin with many raised pustules, as in the described specimen. Cei (1960) describes this species as having a smooth skin and no glandular tympanic ridge but this error may have been due to his having specimens in a poor state of preservation.

Occasionally a vertebral stripe is present. Four immature specimens and three adults have a well-defined stripe extending from the tip of the snout to the vent.

Although there is extremely little variation in the shape of the sternum in the individuals examined, the specimen from Munoz Gamero is an exception. It has a short, stumpy sternum with no appreciable style but a widely flared out, notched plate which is quite asymmetrical in shape. On the under surface of the skin in the pectoral area, and loosely anchored to the underlying tissue, was found an ovoid capsule of approximately 3 mm. in length. Mr. Prudhoe of this department kindly examined it and on dissecting it found that it contained a young *Microfilaria* nematode. The irritation to the surrounding tissue produced by the nematode had

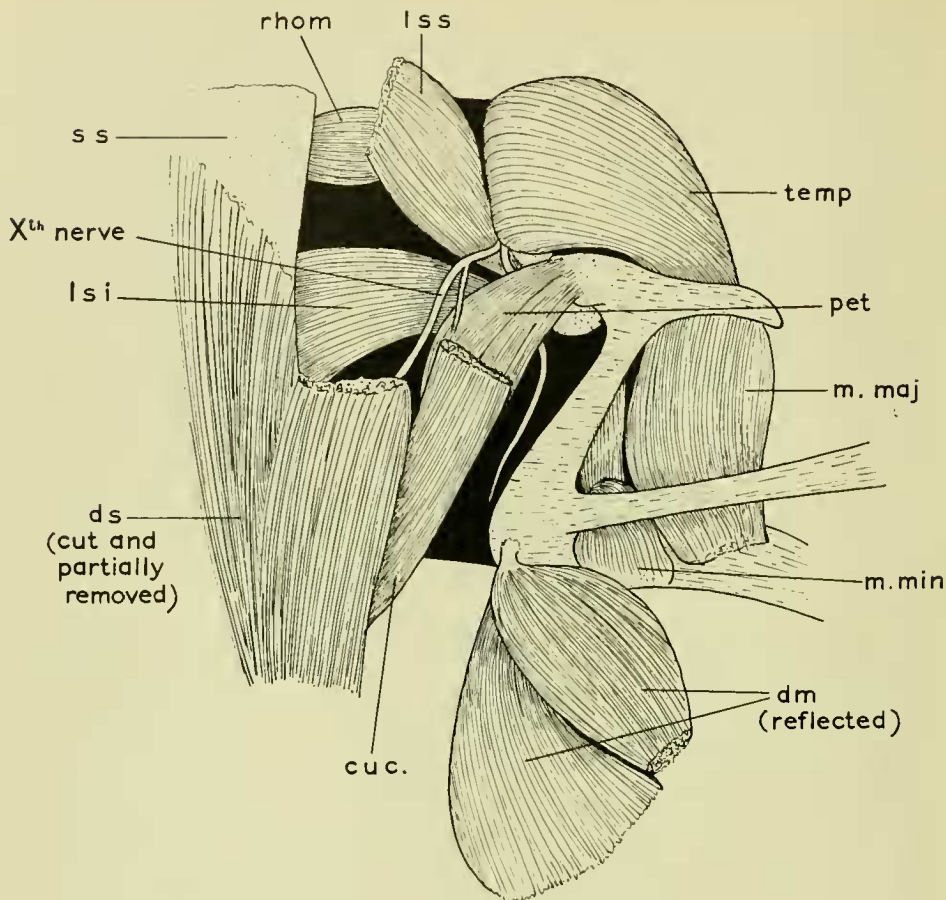


FIG. 3. *E. coppingeri*. Lateral view of the head showing the muscles of the otic region.

Explanation of Reference Letters Used in Figures

col, columella.

cp, crista parotica.

cuc, musculus cucullaris.

dm, musculus depressor mandibulae.

ds, musculus dorsalis scapulae.

lsi, musculus levator scapulae inferior.

lss, musculus levator scapulae superior.

m. maj, musculus masseter major.

m. min, musculus masseter minor.

op, operculum.

pet, musculus petrohyoideus.

rhom, musculus rhomboideus anterior.

sq, squamosal.

ss, suprascapula.

temp, musculus temporalis.

evidently caused the numerous coats to be laid down encompassing the source of the irritation. The pressure of the "capsule", lying directly ventral to the sternal muscles, may account for the malformation of the sternal cartilage.

SECONDARY SEX CHARACTERS. Conspicuous nuptial pads are present on the medio-dorsal surface of the first and second fingers of two males measuring 53.5 mm. and 56.5 mm. The pads extend distally as far as the bases of the terminal phalanges, are unpigmented and bear large, sharp spines which apparently increase in length and acquire heavily pigmented horn as the individuals reach the peak of the breeding

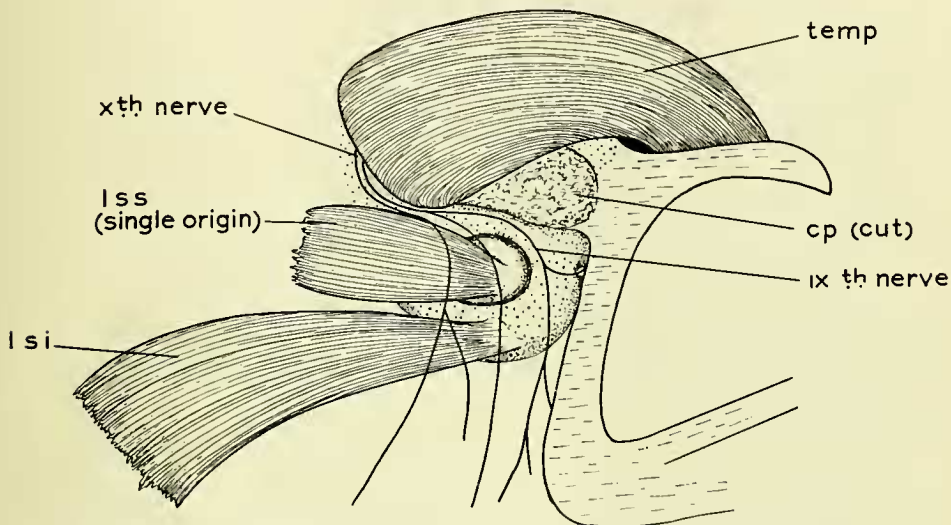


FIG. 4. *E. coppingeri*. The operculum and levator scapulae muscles.
(Muscles attached to the crista parotica have been removed.)
For abbreviations see Fig. 3.

season. On the thumb there may be 18-21 such spines but fewer on the second finger (10-12) Text-fig. 5. On each side of the chest, just posterior but close to the folds described for the specimen C.N.H.M. 44219, are well-defined circular asperities consisting of closely set, conical, pigmented tubercles. These pads of excrescences are separated from each other by a distance equal to the length of the inner metatarsal tubercle. From the condition of the gonad in adult males, it appears that the pad on the thumb develops first, then the chest asperities develop at about the same time as the pad on the second finger. Only after the chest pads become differentiated do the spines on the fingers become cornified and acquire melanin. At Bariloche the height of the breeding season occurs late in November. Adult males collected about that time of year have fully developed nuptial pads but by December the spines have regressed. A female collected on 1st December and another taken on the 21st January contain mature ovarian eggs.

ECOLOGY. The following is an extract from a personal communication to the author from Dr. Holdgate, zoologist with the Royal Society Expedition to Southern Chile, of the habitats of the examples of *coppingeri* that were taken at Puerto Edèn and on Munoz Gamero :

" 1. ' Plateau below S. Peak, Puerto Edèn. Under stone, 2100' 7.12.1958'.



FIG. 5. *E. coppingeri*, Z.M.B. 29470. Nuptial asperities on dorso-medial surface of hand of mature male.

" GENERAL

" The country around Puerto Eden, Wellington Island, forms part of the zone described by Godley (1960) as ' Magellanic moorland '. It is mountainous, the peaks on the island itself reaching from 2500 to 4500 ft., and the permanent snow line is at about 3500 ft. There are small glaciers on the highest peaks. The lower country and all the valleys show signs of intense glaciation. The rock is mainly dioritic with some schist etc. The vegetation includes some patches of highly impoverished evergreen rain forest, which is dominated by the evergreen southern beech *Nothofagus betuloides*. This forest is restricted to the coastal strip, the shores of some lakes, gullies, and odd patches on the flanks of the mountains perhaps where the soil is deepest. Between the forest patches there are tracts of bog dominated by the ' carpet ' plants (*Astelia pumila*, *Donatia fascicularis*, *Gaimardia* sp., *Oreobotus* sp. etc.). On steeper slopes there are tracts of ground with grass tussocks and tussocks of *Schoenus laxus*.

" The forest becomes stunted with increasing altitude, and at about 2000 ft. the evergreen beech is replaced by the deciduous *Nothofagus antarctica*. This forms tangled, dwarf thickets. Its upper limit is at about 2500 ft. By 2000 ft. the peat forming carpet plants no longer cover much of the ground surface, and peat accumulation is negligible. Above 2500 ft. there is virtually no bog, except in wet hollows, and above 3000 ft. the vegetation consists of low cushions

of *Azorella* sp. and allied upland low-growing species, occasional herbs such as *Senecio* spp., and mosses and liverworts. Stones are scattered everywhere on the uplands and major rock outcrops account for an appreciable part of the land surface. All vegetation stops at about the 3200–3500 ft. level.

“DETAIL

“The specimen of *Eupsophus* was found under a stone, turned in searching for insects. The site lay on open ground above the main evergreen forest which grows fairly thickly on the flanks of this particular mountain. The country was an undulating plateau, with small craggy hills rising about 50 ft. above the general surface, and small valleys of comparable depth. The animal was taken on a low knoll scattered with stones, and the vegetation was here a wet mat of grasses, cyperaceae, and a small amount of the cushion plant *Astelia pumila*. The soil was organic but not a pure peat: lumbricoid oligochaetes were present in it.

“In this site the species therefore was inhabiting open moorland like the other amphibia (*Bufo variegatus*) taken on the expedition at Edèn.

“2. ‘Peninsula Munoz Gamero, under stone at about 100 m. on mountain of 750 m. 27.12.1958.’

“This locality, like Puerto Edèn, lies in the Magellanic moorland zone and has a discontinuous forest, restricted to the lowlands, boggy vegetation of ‘carpet plants’ above that, and stony mountainside at a higher level. The extent of forest is smaller in this area which is much farther South than Wellington I.: the peat-forming vegetation on this particular mountain also stopped at a lower level (about 1000 ft.).

“DETAIL

“The specimen was taken in the lowland area, outside the forest, on an open boggy hillside. The vegetation, and also occurrence of the animal under a stone, are closely comparable with the Puerto Edèn record.”

At Casa Pangué and at Puella in Llanquihue Province the biotope of *coppingeri* is said to be wet forest. Further ecological details of this region are given in the account of F. W. Edwards’ itinerary in Alexander (1929).

DISTRIBUTION. Angol, Malleco Province to Peninsula Munoz Gamero, Magallanes Province. Also in Rio Negro Province, Argentine.

Eupsophus nodosus (Duméril & Bibron)

(Text-figs. 6–10; Pls. 2–3)

Cystignathus nodosus Duméril & Bibron, 1841, p. 413 (type locality, Valparaiso).

Cacotus maculatus Günther, 1868, p. 482, pl. 38, fig. 5 (type locality, Chile).

Borborocoetes verrucosus Philippi, 1902, p. 83 (type locality, Province of Cautin)

Borborocoetes kriegi Müller, 1926, p. 195 (type locality, near Valdivia).

Borborocoetes kriegi Müller & Hellmich, 1932, p. 204.

MATERIAL EXAMINED

CHILE :

Valparaiso : M.H.N.P. 763, 763a (types of *C. nodosus*).

Santiago : Cordilleras of Santiago, N.H.M.V. 4661 (2 exs.).

Maule : Ninhue, B.M. 1920.1.20.4050 (2 exs.).

Malleco : Angol, C.N.H.M. 23897.

Valdivia : N.M.B. 1518.

No precise locality : B.M. 60.9.23.4-5 (re-registered 1947.2.19.98-99 ; types of *C. maculatus*) ; Z.M.B. 4484 (2 exs.) ; Z.M.B. 3340 ; R.N.H.L. 2068 (11 exs.) ; N.H.M.V. (no register number, 1 ex.).

DIAGNOSIS. Medium- to large-sized frog, somewhat rectangular in outline. Head flattened, distinctly broader than long ; snout fairly long, broadly rounded. Vomerine teeth in two almost straight groups between the choanae. First finger equal to or longer than second ; toes with only the barest rudiment of web, but flattened along sides and with a slight seam ; subarticular tubercles very prominent and conical ; supernumerary metatarsal tubercles present ; tarsal ridge present. Skin of adults pitted slightly with small, round glandular swellings. Middle ear present but small, diameter of tympanum about $\frac{1}{4}$ the horizontal diameter of the eye, not visible externally. Mature males in the breeding season with spinous nuptial pads covering a prominent bony protuberance on the basal phalanx of the thumb and the inner aspect of the second finger ; two longitudinal crests on the humerus, the ventral crista medialis being visible externally as a curved projection ; patches of asperities on each side of the chest ; no vocal sacs.

DESCRIPTION. Half-grown ♂, Chile, R.N.H.L. 2068. Habitus stocky, toad-like in appearance. Tongue cordiform, the posterior $\frac{1}{3}$ free, feebly notched, occupying $\frac{2}{3}$ of the mouth width. Vomerine teeth in two, small, only slightly oblique groups between the anterior halves of the circular choanae and closer to each other than to the choanae. Snout moderately long, semicircular in dorsal view, $1\frac{1}{2}$ times the horizontal diameter of the eye, rounded in profile, the upper jaw barely extending beyond the lower jaw. Nares dorsolateral, not projecting, the distance between the middle of the nares equal to the interorbital space which is narrower than the upper eyelid, their distance from the anterior borders of the eyes $1\frac{1}{2}$ times greater than from the tip of the snout. Canthus rostralis almost straight but rather indistinct ; loreal region flat and strongly oblique, upper lip flaring out below. Eye large and prominent, not projecting beyond the jaws in dorsal view. Middle ear apparatus present but feebly developed and deeply seated ; annulus tympanicus incomplete dorsally ; extra columellar cartilage very large and pear-shaped, occupying almost the full area of the tympanum ; horizontal diameter of the tympanum $\frac{1}{4}$ that of the eye ; operculum entirely cartilaginous. A glandular fold from behind the eye to the arm insertion. Omosternum cartilaginous with moderately long stem and only very slightly dilated tip ; sternum cartilaginous, twice the length of the omosternum, of moderate width medially, expanded posteriorly, deeply emarginate, only very slightly longer than the epicoracoids. Tibio-tarsal articulation of the adpressed hind limb reaches to the temporal area. Fingers free of web, first finger

slightly longer than the second, subarticular tubercles very prominent, supernumerary palmar tubercles present. Tips of toes and fingers rounded with simple terminal phalanges. Toes with the barest rudiment of web; only an indication of toe fringes; a short, somewhat indistinct tarsal ridge present. An oval inner, and a small, rounded outer metatarsal tubercle present, the inner tubercle approximately equal to the distance from the tip of the first toe to the distal edge of the tubercle; supernumerary metatarsal tubercles present, at least one at the base of each digit;

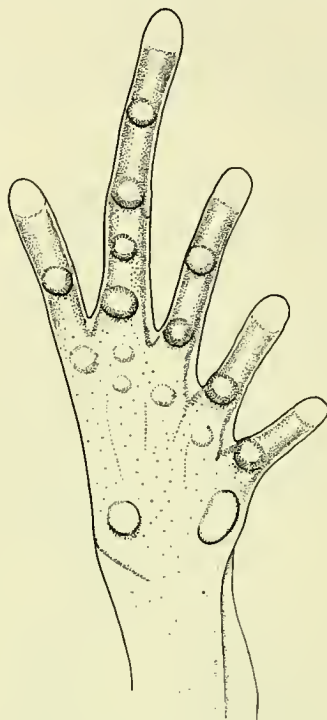


FIG. 6. *E. nodosus*, M.H.N.P. 763a (one of the types). Ventral view of foot. ($\times 17.5$.)

subarticular tubercles very pronounced and conical. Skin on the upper parts of the body pitted, with small, round, slightly elevated warts on the dorsum and upper surfaces of the thighs; ventral surface smooth except for a granular area around the vent and on the inside of the thighs; limbs smooth. Dorsum with a light triangular area on the snout, a dark interocular band and obscure dark marblings; the dorsal warts tend to be light coloured in the centre and edged with dark ocelli. A dark band along the canthus and loreal region is continued posteriorly as an oblique bar from behind the eye, across the temporal area to behind the arm insertion. There is also a conspicuous light, transverse line just posterior to the vent. Venter mottled, particularly on the throat. Limbs markedly cross barred.

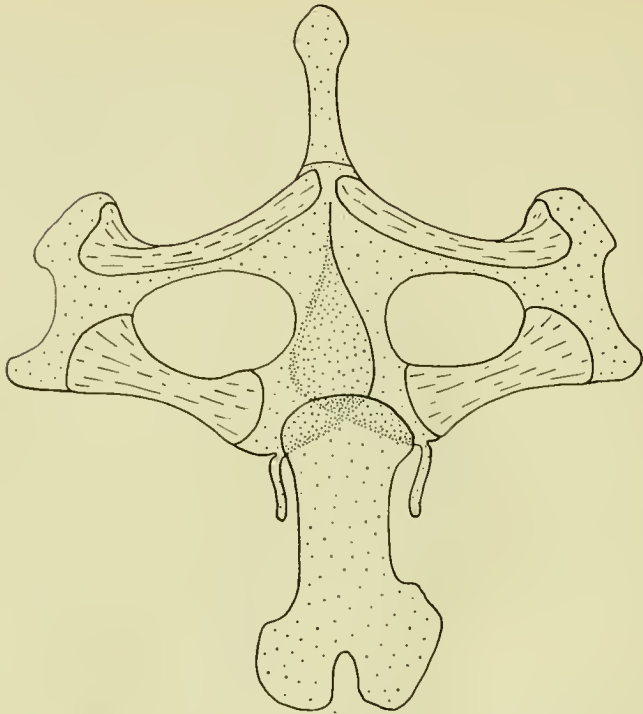


FIG. 7. *E. nodosus*, Z.M.B. 4484. Ventral elements of the shoulder girdle. ($\times 17.5$.)

Measurements :

Length of body	. 44.2 mm.
Length of tibia	. 19.3 mm.
Length of foot	. 21.6 mm.
Length of head	. 14.7 mm.
Width of head	. 16.3 mm.

VARIATION. In its bufonid appearance and thick, pitted, glandular skin bearing numerous warts this species may readily be confused with *coppingeri* but it can be distinguished from it and from all other Chilean species of *Eupsophus* by its webbing, supernumerary tubercles on the foot, male secondary sexual characters and small, deeply seated tympanum. There is little variation in the individuals examined; all young and immature specimens have similar scattered white tubercles on the dorsum and the position of the vomerine teeth is fairly constant. In the adult males examined, the sternum has become calcified, whereas in younger individuals it is wholly cartilaginous. The length of foot relative to total length varies from

0.43–0.54 ($M = 0.48$; $N = 24$) and the tibia length as a proportion of total length varies from 0.37–0.50 ($M = 0.42$; $N = 24$).

REMARKS. The type specimens of *Cacotus maculatus* Günther were compared with the series of *nodosus*, including the types, and were found to agree well in characters. The figure in Dr. Günther's paper of the under surface of the foot of one of the types illustrates the supernumerary tubercles on the metatarsals which are characteristic of *nodosus* but the tarsal fold which is present in the type specimens is not apparent in the figure. Although Boulenger (1882) stated that *maculatus* lacked a tympanic disk, an examination of the ear region by reflecting the covering skin discloses a complete, although poorly developed middle ear apparatus with a

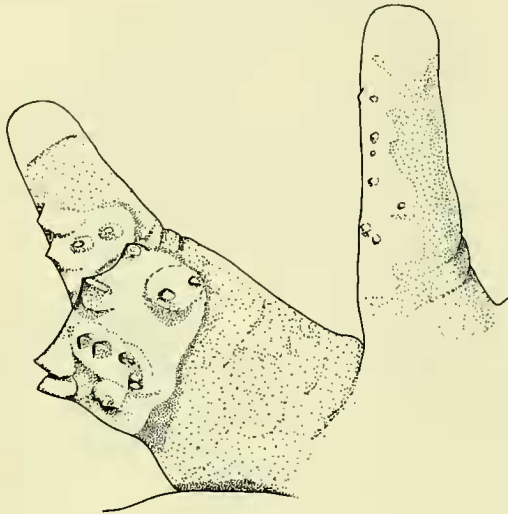


FIG. 8. *E. nodosus*, N.H.M.V. 4661.1. Nuptial asperities on dorso-medial surface of hand of mature male. ($\times 17.5$.)

pear-shaped tympanic annulus and a large extra columella cartilage. No other character remains by which *maculatus* can be distinguished from *nodosus* and the two must be considered synonymous.

It is unfortunate that the types and other examples of Müller's *Borborocoetes kriegi* which were housed in the Zoologische Sammlung des Bayerischen Staates at Munich were destroyed during the Second World War. However, from the detailed descriptions by Müller (1926) and later by Müller & Hellmich (1932) there is little doubt that *kriegi* too falls into the synonymy of *nodosus*, the only conflicting part in the descriptions being the width of the interorbital space which in *kriegi* is said to be distinctly broader than the upper eyelid. Their detailed description of the breeding male *kriegi* particularly strengthens the probability of the two species being synonyms for all the secondary sex characters described above for *nodosus* were apparently developed in the *kriegi*.

Cei (1960) has included *E. verrucosus* Philippi in the synonymy of *nodosus* but in view of the conflict in the descriptions of the characters of the two species his judgment is open to question. Vellard (1947) re-described *verrucosus* stating that an internal vocal sac is present. No vocal sacs are present in male *nodosus* in full breeding condition. Furthermore, he makes no mention of supernumerary tubercles

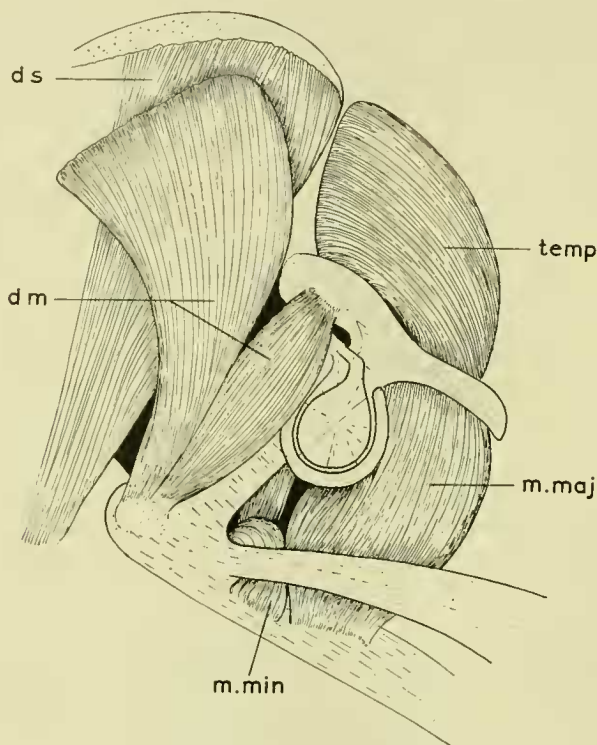


FIG. 9. *E. nodosus*, N.H.M.V. 466.1. Lateral view of head showing tympanic annulus, extra columella and neighbouring muscles. For abbreviations see Fig. 3.

under the metatarsals nor of the length of the first finger, characters typical of examples of *nodosus* of all age groups. However, the position of the vomerine teeth, the reduced lateral toe fringes, the invisible tympanum and the shape of the head are suggestive of a closer relationship with *nodosus* than with any other Chilean species of *Eupsophus*.

SECONDARY SEX CHARACTERS. At the height of development the base of the thumb of the male *nodosus* is very bulbous and bears clusters of conical tubercles which are tipped with horn. Similar tubercles are present on the proximal half

of the penultimate phalanx of the thumb which is not swollen. The median surface of the second finger bears a few scattered, spinous tubercles. The irregularly shaped, glandular, spinous knob on the pollex surmounts a bony protuberance on the distal half of the inner aspect of the metacarpal. The fore limbs of a breeding male are massive with an enormous increase of humeral musculature and an associated increase in their attachment area on the crests on the humerus which have expanded to form two longitudinal flanges, partially enclosing a deep sulcus and of unequal height, the lower one being more prominent and visible externally as a curved projection. The males at maximum development also have round patches of chest asperities consisting of sparsely set, conical warts, somewhat similar in appearance to those on the hand but not as spinous and without pigment. These chest pads are divided by a space equal to the horizontal diameter of the eye.

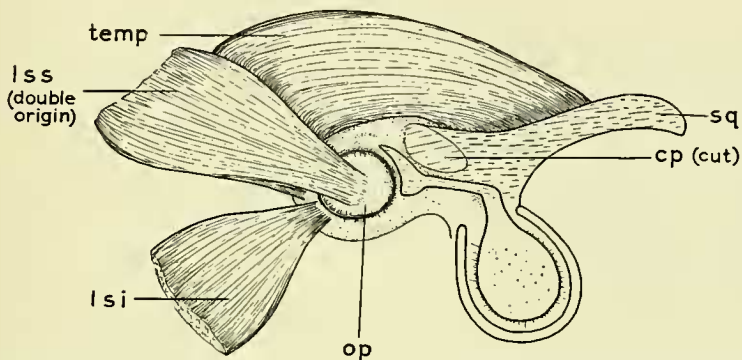


FIG. 10. *E. nodosus*, N.H.M.V. 4661.1. The operculum, elements of the external ear and levator scapulae muscles. (Muscles attached to the crista parotica have been removed.)
For abbreviations see Fig. 3.

In addition to the characters described above, the type of *kriegi* was described as having in front of the axilla several warts, some with, some without spines; these axillary warts were absent from the specimen which was collected 5. x. 1930 and was described later by Müller & Hellmich. It may be that the *nodosus* males in the series examined were not taken at the very peak of sperm activity but that such spinous warts in the axilla are the last sex character to develop. Unfortunately the reproductive organs have been completely removed from the apparently sexually mature male collected at Valdivia, which was examined (N.M.B. 1518).

SEX DIMORPHISM. On the basis of the series at hand it is impossible to judge whether there is any dimorphism in size between the sexes as none of the females is sexually mature. The largest specimens that were examined, 59.3 mm. and 69.3 mm., are both sexually mature males. The male specimen identified as *kriegi* and described by Müller & Hellmich measured 77 mm. while the type of *kriegi*, also a mature male, had a total length of 75 mm.

ECOLOGY. No ecological data on the series examined is available. The Munich Museum specimens identified as *kriegi* were found at night in a heavily wooded

ravine with a permanent stream close by at an altitude of 1,200 m. in the environs of Santiago. The type of *kriegi* was collected in an area rich in virgin rain forest near Valdivia.

As regards the habits of this species, Parker (1940) observed that burrowing forms tend to have a larger extra plectral cartilage, a more deeply seated and smaller tympanum and a thickened skin. *E. nodosus* in possessing all these features may well be a cryptozoic species; its short, robust limbs, bufonid-like foot and conical sub-articular and supernumerary tubercles also suggest this mode of life.

DISTRIBUTION. Valparaiso to Valdivia.

Eupsophus roseus (Duméril & Bibron)

(Text-figs. 11-15; Pl. 4, fig. 1)

- Cystignathus roseus* Duméril & Bibron, 1841, p. 414 (type locality, Chile).
Borborocoetes grayi Bell, 1842, p. 36, pl. 17, fig. 2 (type locality, Valdivia).
Borborocoetes bibroni Bell, 1842, p. 35, pl. 17, fig. 1 (type locality, Valdivia and at Chiloé).
Cyclorhamphus fasciatus Peters, 1869, p. 789 (type locality, Puerto Montt).
Cacotus calcaratus Günther, 1881, p. 19 (type locality, Chiloé).
Borborocoetes calcaratus Boulenger, 1882, p. 256, pl. 17, fig. 1.
Borborocoetes masareyi Roux, 1910, p. 111 (type locality, Coronel, Chile).
Eupsophus maculatus Schmidt, 1954, p. 5.
Eupsophus grayi Capurro, 1957, p. 24.
Eupsophus grayi Cei, 1960, p. 3.

MATERIAL EXAMINED

CHILE:

- Santiago*: Z.M.B. 5363 (2 exs.).
Concepcion: Tumbes, Z.M.B. 13396 (3 exs.); Pelun, B.M. 1905.5.31.26;
 Coronel, N.M.B. 2789 (type of *B. masareyi*).
Malleco: Cabreria, 800 m., Nahuelbuta, C.N.H.M. 44181-4, 44215.
Cautin: Maqushue, Temuco, B.M. 1907.1.22.22-29.
Valdivia: Valdivia, Z.M.B. 9826, N.M.B. 1523-1526, N.H.M.V. 4660.3, 4660.5-6, 4660.10, 4660.12, 4663.1, 4663.9-13, 4663.8, 4662.14-16, 4654 (4 exs.), N.H.M.V. (2 exs., no register number), Z.M.B. 5365, B.M. 89.12.16.181-182, 1920.1.20.347, 45.5.25.25 (type of *B. grayi*); Panguipulli, M.C.Z. 8653-8656; Desague, N.H.M.V. (1 ex., no register number); Corral, M.C.Z. 13742, Z.M.B. 13427 (8 exs.).
Llanquihue: Puerto Montt, Z.M.B. 6617 (type of *C. fasciatus*), N.H.M.V. 4654 (2 exs.); Pangué, N.H.M.V. 4654 (1 ex.), N.H.M.V. (2 exs., no register number).
Chiloé: B.M. 1920.1.20.468, 68.9.22.8 (type of *C. calcaratus*); Ancud, B.M. 1927.5.7.10-11; NE. Ancud, 41° 51' 50" S., 73° 49' 20" W., U.B. 62-63; S. of Lechagua, 41° 53' 18" S., 73° 51' 55" W., U.B. 26-36, 38-40, 42, 44, 46-52, Z.I.L.U. (4 exs. no register number); C.S. Carlos, N.H.M.V. 4654 (1 ex.).

Chonos: B.M. 45.5.25.43 (type of *B. bibroni*).

No precise locality: Z.M.B. 3132, 3342-3, C.N.H.M. 39994, N.H.M.V. 4658 (3 exs.), 4655 (10 exs.), M.H.N.P. 762, 762a (types of *C. roseus*); C. Chile, Z.M.B. 13918; S. Chile, B.M. 91.8.29.16.

ARGENTINE:

Rio Negro: San Martin de Los Andes, N.H.M.V. (3 exs., no register number); Bariloche B.M. 1932.10.2.64-65, N.H.M.V. (1 ex., no register number), N.H.M.V. 4655 (4 exs.).

DIAGNOSIS. Medium-sized frog, adults 32.0-46.0 mm., plump build with short, blunt snout; head as broad or slightly broader than long; vomerine teeth in two straight or slightly oblique groups well behind the posterior margin of the choanae; first finger shorter than second; toes with only a rudiment of web; subarticular tubercles prominent and conical; usually a heel tubercle; no tarsal ridge; skin of adults shagreened; middle ear present, tympanic annulus usually visible externally; mature males with large nuptial pads on dorsal surface of first and second fingers and with paired internal vocal sacs.

DESCRIPTION. Adult ♀, Panguipulli, M.C.Z. 8653. Plump habitus. Tongue broadly rounded, its posterior $\frac{1}{3}$ free and with only a faint indication of a notch; a very narrow, inconspicuous seam forming a fringe round the edge of the tongue. Vomerine teeth in two, strong, oblique groups well behind the posterior borders of the semicircular choanae and separated from each other by a distance equal to $1\frac{1}{2}$ times the width of one of the choanae. Snout fairly long, rounded in dorsal view, in profile slanting backwards towards the lip border and distinctly rounded, almost equal to the horizontal diameter of the eye. The upper jaw barely extends beyond the lower jaw. Nares dorsolateral, slightly projecting, the distance between the middle of the nares equal to the width of the interorbital space which is as broad as the upper eyelid, their distance from the anterior borders of the eyes about equal to their distance from the tip of the snout. Canthus rostralis curved and prominent; loreal region concave and oblique with upper lip flaring out below; eye large and prominent, not projecting beyond the jaws in dorsal view. Middle ear apparatus complete; the tympanic annulus conspicuous externally, its diameter $\frac{1}{2}$ the eye width; extra columella baton-shaped; operculum partly calcified. Omosternum cartilaginous, moderately long stem and dilated tip; sternum also cartilaginous, with dumpy style and slightly expanded plate, almost twice the length of the omosternum and $1\frac{1}{4}$ times the length of the epicoracoids. Tibiotarsal articulation of the adpressed hind limb reaches to the anterior border of the eye. Fingers free of web, first finger shorter than second, subarticular tubercles moderate. Tips of fingers and toes rounded, with simple terminal phalanges. Toes rounded without webbing but metatarsals partially separated by web. A large elongate inner, and a small, rounded outer metatarsal tubercle present; supernumerary metatarsal tubercles absent; subarticular tubercles well developed; a small heel tubercle present. Skin on upper parts of body shagreened with thickened, slightly pitted area in the paratoid region and at the corners of the mouth. A pronounced glandular,

dorsolateral fold extends from the posterior edge of the eyelid, passes above the tympanum and posteriorly to midway between the arm and the leg insertion. Ventral surface smooth, except for a granular area around the vent and on the

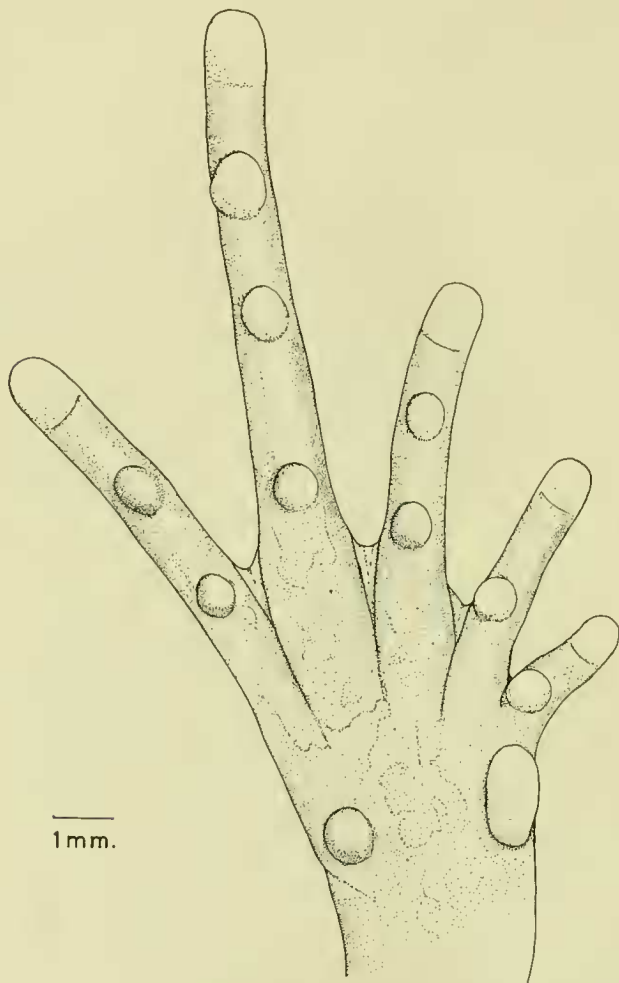


FIG. 11. *E. roseus*, U.B. No. 49. Ventral view of the foot. ($\times 17.5$.)

insides of the thighs; limbs smooth. Dorsum with a conspicuous light patch on forehead, a dark triangular mark in post interorbital area and posteriorly an indistinct hour-glass pattern; dark patches on either side of the lumbar region. Hind limbs cross barred; venter immaculate.

Measurements

Length of body	. 39.5 mm.
Length of tibia	. 20.7 mm.
Length of foot	. 18.0 mm.
Length of head	. 14.2 mm.
Width of head	. 15.5 mm.

VARIATION. Remarks on sex dimorphism, adult size, percentages of specimens having heel tubercles and two metatarsal tubercles are contained in the following section on "Remarks".

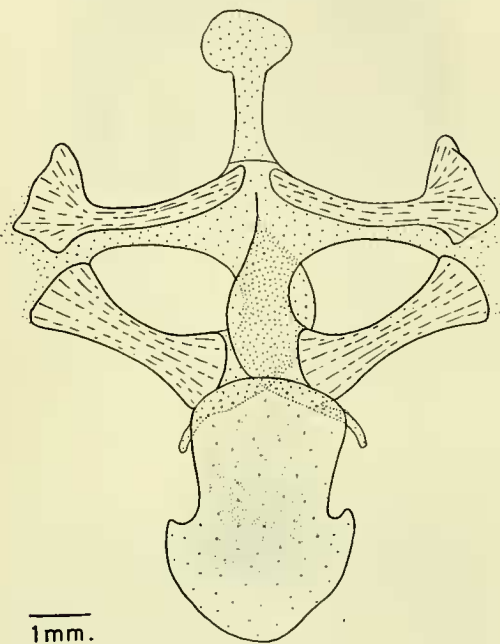
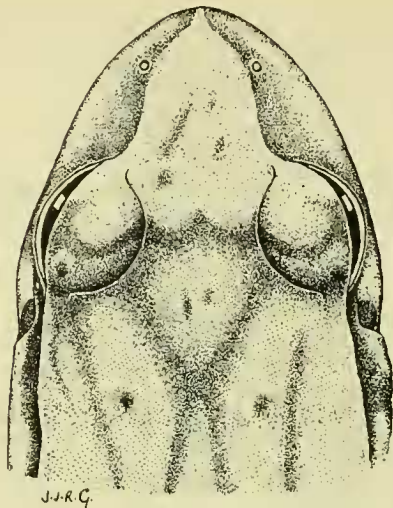


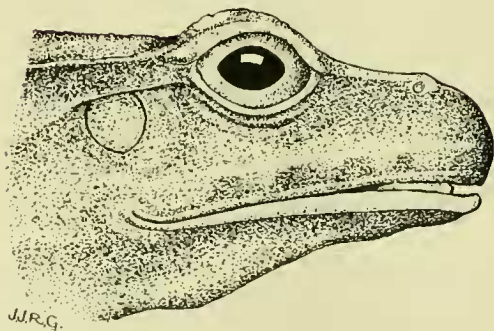
FIG. 12. *E. roseus*, Z.M.B. 13918. Ventral elements of the shoulder girdle. ($\times 17.5$).

Notes were made on the position of the vomerine teeth in 119 individuals. There are no exceptions to the rule that in examples of *roseus* the teeth are placed behind the posterior level of the choanae. Three specimens have contiguous groups and two specimens are aberrant in having only one; otherwise all have two slightly oblique groups separated from each other on the mid-line.

The proportions of the ventral elements of the pectoral girdle vary considerably, although the sternum is consistently longer, even if only slightly, than the epicoracoid cartilages. The length of the omosternum relative to the epicoracoids is especially variable and may be from $\frac{1}{2}$ to $\frac{3}{4}$ its length. Calcification of the whole of



a



b

FIG. 13. *E. roseus*. a. Dorsal view of head ; b. Lateral view of head.

the sternal style, or at least the central portion of it takes place in many of the fully-grown specimens but among a collection of adults of approximately similar body size taken from one locality, the numbers of individuals with calcified style about equal those that are wholly cartilaginous.

Foot length/Total length . . . 0.46–0.60 ($M = 0.52 : N = 91$).

Tibia length/Total length . . . 0.45–0.60 ($M = 0.52 : N = 88$).

REMARKS. *Cystignathus roseus* was described from two sexually mature individuals, a male and a female. Notwithstanding the fact that their present condition is bleached, soft and flabby, certain diagnostic characters are still manifest,

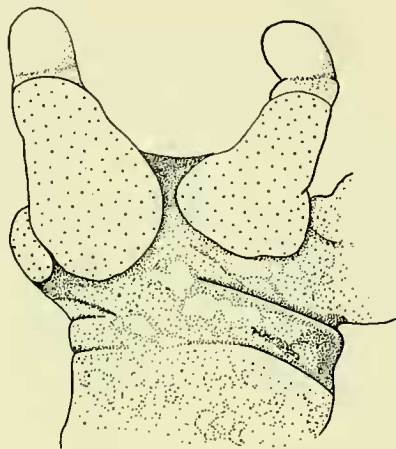


FIG. 14. *E. roseus*, C.N.H.M. 39994. Nuptial pads on hand of mature male. ($\times 17.5$)

notably the position of the vomerine teeth, which are in slightly oblique groups behind the posterior level of the choanae, the remnants of a dorsolateral fold, the velvety clusters of asperities on both the first and second fingers of the male and an internal vocal sac in the male. In addition, there is in the male a suggestion of a heel tubercle. All these characters are consistent with the chief diagnostic characters of Bell's *grayi*. But apart from morphological considerations, the colour pattern, which was so ably described by Duméril & Bibron, fits exactly a large proportion of specimens that have been identified as *grayi* by previous workers. The only major discrepancy between the types of *roseus* and individuals identified as *grayi* is the size of the female *roseus* type which is 46.5 mm. in total length and is almost 2 mm. greater than the largest female *grayi* that has been measured. The size range of mature females of *grayi* is 32.0–44.7 mm. with a mean of 38.6 mm. ($S.E._m = 0.50 ; N = 33$). However, too great emphasis need not be placed on this size difference between the species particularly as the types of *roseus* are without a precise locality and it has been noted in the examination of the *grayi* material that there is a cor-

relation between size at sexual maturity and geographical distribution, individuals from the northern part of the range of the species tending to be larger while the population occurring in insular Chilóe in the south tends to be small. An explanation for the extreme size of the *roseus* types could lie in the fact of their having been taken in an area towards the northern limit of the distribution of the species. Certainly there is no justification for maintaining *grayi* as a species distinct from *roseus*.

Nieden (1923) placed *E. bibroni* (Bell) and *E. fasciata* (Peters) in the synonymy of *E. grayi* but he maintained that Roux's *masareyi* could be separated from *grayi* on the basis of skin texture, number of metatarsal tubercles and also skin folds. The type of *masareyi* has been examined by the present author; its condition is poor and the specimen is hard and brittle but there is no doubt that only one metatarsal tubercle is present and no heel tubercle exists. But only 61% of the individuals studied here possess a heel tubercle although 96% have two metatarsal tubercles. The exceptions are adults of both sexes and from localities throughout the range. In other characters *masareyi* agrees well with the description of *roseus* and with the specimens examined and there seems no reason to suppose that *masareyi* is other than a synonym of *roseus*.

Although up to the present time *E. calcaratus* (Günther) has been considered a valid species and was thought to differ from the *grayi-roseus* group in lacking a tympanum (Boulenger, 1882 and Nieden, 1923), the type of *calcaratus* does possess a tympanum. The degree to which the middle ear structures are developed immediately suggests an immature specimen and this is borne out by an examination of other anatomical structures, notably the shoulder girdle and sex organs. The type has a heel tubercle and the position of the vomerine teeth, body proportions and other external characters leave no doubt that the description of *calcaratus* was based on a young specimen of *roseus*. Also the "V"-shaped mid-body ridge present in the type of *calcaratus* and apparent in the figure in Boulenger's catalogue occurs frequently in young and half-grown examples of *roseus*.

All the Lund University Chile Expedition amphibian material, which was reported on by Schmidt (1954), has been examined and the specimens identified as *E. maculatus* are in fact examples of *roseus*.

The description given by Cei (1960) of the colour, vomerine teeth and size and the figure of specimens determined by him as *roseus* clearly indicate that his series does not belong to *roseus* but should be referred to the new species described below.

A few comments on the notes and photographs relating to the species *roseus* and *grayi* in Capurro's paper (1957) are called for on account of the confusion in identifications and the apparent transposition of the captions to the photographs. Although his description of *E. grayi* suggests that it was based on examples of *E. roseus* (D. & B.) the photograph bearing the caption "*E. grayi*" is not of an example of *roseus* but of the species described in the following section. Likewise, there is confusion with his description and figure of what he terms *E. roseus* and since the frog that is photographed resembles an individual of D. & B.'s *roseus* it is possible that the error has been made by the printer.

SECONDARY SEX CHARACTERS. Mature males have paired internal vocal sacs opening on the floor of the mouth in wide slits. The nuptial pads present on the first

and second fingers consist of clusters of fine brown spinules, are restricted to the dorsal surface and extend to the bases of the distal phalanges. The inner palmar tubercle also bears asperities which like those on the fingers are granular.

Unlike *E. taeniatus*, in which all the adult males have vocal sac openings on the floor of the mouth, the external sex characters of *roseus* appear to regress between the mating seasons and specimens taken at these periods can be sexed only by an examination of the gonads. Seemingly there is no predetermined order of development of the different sex characters for in some cases the sac openings

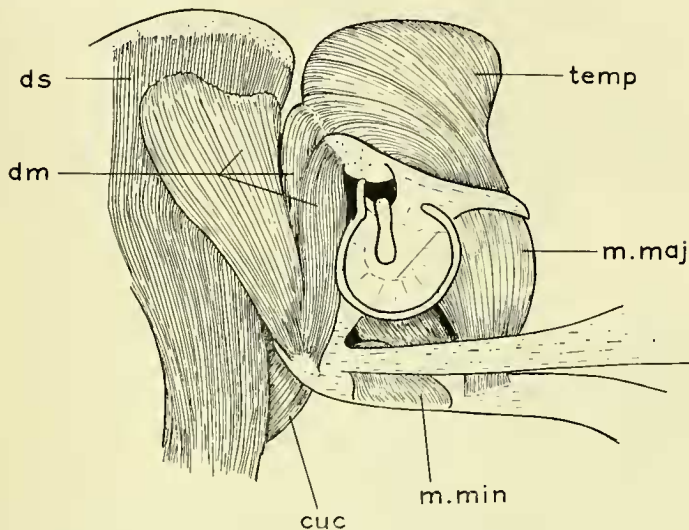


FIG. 15. *E. roseus*, U.B. No. 42. Lateral view of head showing tympanic annulus, extra columella and neighbouring muscles.
For abbreviations see Fig. 3.

develop prior to the nuptial pads while in other examples the reverse order is the case but the openings are always present by the time the pads acquire spinules and a deposition of pigment.

Exceedingly few of the examples studied bear any collecting dates and consequently little information on breeding dates is available but females bearing ripe ova were taken at Bariloche during November, at Nahuelbuta on the 1st December and at Lechagua on 18th November as well as on 1st January and 6th March.

COLOUR. The colour in life of some of the *roseus* collected near Ancud was noted by the collector as being mottled yellow-red, red, grey and brown. A few of the specimens that are preserved in the collections of the Vienna Museum still retain their original coloration. The ground colour of these individuals is magenta with a brown band on the canthus, across the tympanum and along the lateral fold. Numerous other brown marks are apparent on the haunches and on the inter-

orbital region; the cross barring on the limbs and the semicircular shoulder marks are also brown. The venter is cream suffused with rose.

Duméril & Bibron's description of the coloration of the type specimens of *roseus* is reproduced here verbatim since it is so detailed and exact.

"Le dessus de la tête, le dos, la face supérieure des membres et même les flancs offrent une teinte rose; l'extrémité du museau et les régions frénales sont colorées en brun pâle, ainsi que les tempes et les épaules; mais non d'une manière uniforme, car on y voit un semis de points blanchâtres. Il y a des dessins bruns, irréguliers sur la nuque, et des bandes de la même couleur en travers des jambes et des tarses. La partie postérieure des cuisses est ponctuée de blanc sur un fond noirâtre. Un mélange de brun fauve et de blanc sale est répandu sur la gorge, et sur la face inférieure des membres. La ventre est d'un blanc grisâtre."

ECOLOGY. Only the Lund University Chile Expedition specimens bear ecological data. Descriptions are given by Brattström & Dahl (1952) and Schmidt (1954).

DISTRIBUTION. *E. roseus* occurs as far north as Santiago de Chile and extends south to the Chonos Archipelago; it occurs also in the Rio Negro Province of Argentine.

***Eupsophus vertebralis* sp. nov.**

(Text-figs. 16-18; Pl. 4, fig. 2)

Borborocoetes roseus Boulenger, 1882, p. 253 (nec Duméril & Bibron).

Eupsophus roseus Schmidt, 1954, p. 5.

Eupsophus roseus Capurro, 1957, p. 24.

Eupsophus roseus Cei, 1960, pp. 1-13.

MATERIAL EXAMINED

CHILE:

Holotype: Adult ♀ Valdivia, Chile, N.H.M.V. 4660.1, collected by Steindachner, 1881.

Paratypes:

Valdivia: B.M. 1932.10.2.68-71, A.M.N.H. 23931, N.H.M.V. 4660 (2, 4, 7, 8, 9, 11, 13), 4662.1-13, 4663.2-7, 4657 (6 exs.), 4656, 13331, N.M.B. 1519, Z.M.B. 7082, 9835-6; Corral, A.M.N.H. 22106-7, 22150, Z.M.B. 13388, 13431, 13919; Desague, N.H.M.V. (4 exs., no register number).

Santiago de Chile: Z.M.B. 7082.

Llanquihue: Frutillar, A.M.N.H. 23989 (1 ex.), B.M. 97.1.25.5; Casa Pangué, B.M. 1927.5.7.4-5.

Chiloé: N.H.M.V. 4659; S. Lechagua, Ancud, U.B. 4, 5, 37, 41, 43, 45; Quellon, C.N.H.M. 3715.

No precise locality: B.M. 45.5.25.22, M.C.Z. 2244, Z.M.B. 14033 (2), Z.M.B. 3338.

DIAGNOSIS. A large species of frog (50-66 mm. when mature) with broadly rounded snout and head broader than long; vomerine teeth in two, only slightly

curved groups between the posterior halves of the choanae, separated medially; first finger not longer than second; toes somewhat flattened along sides with a rudiment of web at bases of digits and between metatarsals; subarticular tubercles prominent; no tarsal fold; skin almost smooth, usually with a vertebral band which may be as broad as the distance between the nares; supratympanic fold

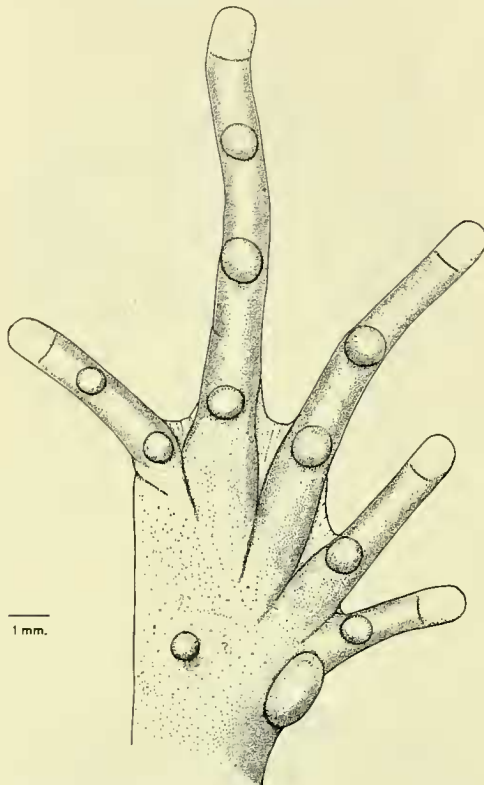


FIG. 16. *E. vertebralis*. Ventral view of foot. ($\times 17.5$.)

present; usually two chevron-shaped ridges between the shoulders; middle ear present and tympanic annulus visible externally; mature males with a white glandular nuptial pad on basal phalanx of thumb and with paired internal vocal sacs.

DESCRIPTION OF HOLOTYPE. Habitus robust. Tongue broadly rounded, its posterior $\frac{1}{3}$ free and slightly notched. Vomerine teeth in two long, only slightly curved groups between and close to the posterior halves of the choanae, separated from each other by a space equal to $\frac{1}{3}$ the width of one of the choanae. Snout fairly long, broad and rounded in dorsal view, equal in length to the horizontal diameter of the eye, somewhat angular in profile, the upper jaw scarcely extending

beyond the lower jaw. Nares superolateral, slightly projecting, the distance between the middle of the nares $1\frac{1}{4}$ times the width of the interorbital space which is narrower than the upper eyelid, equidistant between the anterior borders of the eyes and the tip of the snout. Canthus rostralis rounded and obtuse, not sharply defined; loreal region flat and strongly oblique, upper lip flaring out strongly below; eye large and prominent, not projecting beyond the jaws in dorsal view.

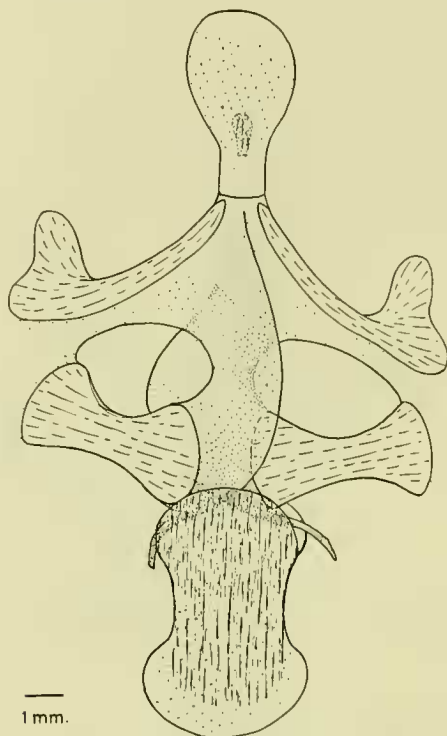
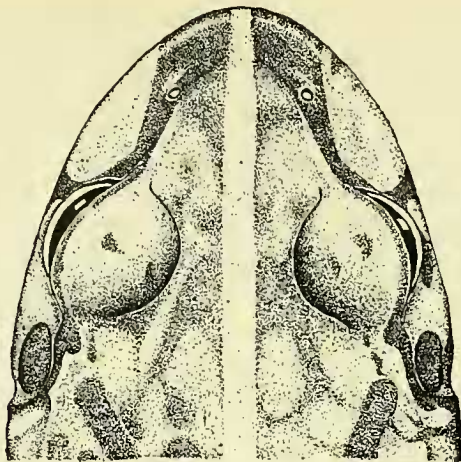
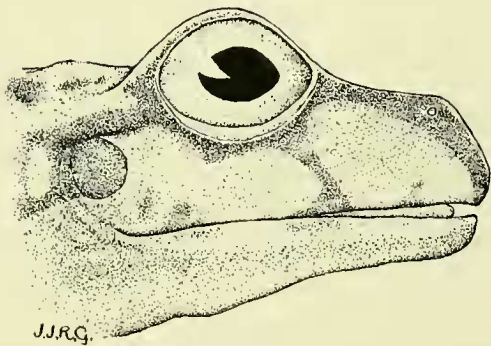


FIG. 17. *E. vertebralis*, N.H.M.V. 4660.1. Ventral elements of the shoulder girdle of the holotype. (Sternum slightly displaced at left side.) ($\times 11.25$.)

Middle ear apparatus complete; the horizontal diameter of the tympanic annulus rather less than half the diameter of the eye and conspicuous externally; columella baton-shaped. Thick, glandular, supratympanic fold present. Omosternum cartilaginous with short broad stem, in the centre of which is a small calcified area, tip strongly dilated; sternum cartilaginous, 1.4 times the length of the omosternum, somewhat rectangular in shape with slight median constriction, almost wholly calcified; epicoracoids 1.25 times the length of the sternum. Tibio-tarsal articulation of the adpressed hind limb reaches to the middle of the eye. Fingers free of web, first finger slightly shorter than second; subarticular tubercles moderate; small



J.J.R.G.

a

J.J.R.G.

b

FIG. 18. *E. vertebralis*. a. Dorsal view of head ; b. Lateral view of head.

supernumerary palmar tubercles present; two palmar tubercles, the outer one partially divided. Tips of fingers and toes rounded, with simple terminal phalanges. Toes with an inconspicuous ridge along the sides and separated by a rudiment of web; between the third and fourth the web extends to the distal edges of the basal subarticular tubercles but is somewhat less between the other digits. Metatarsals partly separated by web. An elongate inner and a small rather inconspicuous outer metatarsal tubercle present; supernumerary metatarsal tubercles absent; sub-articular tubercles rather prominent. Skin on upper parts of body pitted and finely granular with occasional small, elongated tubercles on flanks; between the shoulders on either side of the mid-line are longitudinal crescent-shaped ridges. Venter smooth except for granulations in region of vent and on inside of thighs; limbs smooth. Dorsum mottled, with inconspicuous, light coloured vertebral band from tip of snout to vent; a dark line from tip of snout through nares to anterior border of eye and a dark patch on upper lip just anterior to eye; tympanic area dark; lips not barred. Limbs indistinctly cross barred. Ventral surface cream in alcohol.

Measurements:

Length of body	. 59.4 mm.
Length of tibia	. 27.9 mm.
Length of foot	. 28.3 mm.
Length of head	. 21.7 mm.
Width of head	. 23.7 mm.

VARIATION. The other adults do not vary much from the described specimen and the proportions of the pectoral girdle elements of the holotype are fairly typical of the series examined. The actual variation in the size of the sternum relative to the omosternum is 1.3-2.1 and the relation of the epicoracoids to the omosternum is the same. While in one individual, an adult ♀ from Valdivia in extremely poor condition, the vomerine teeth are behind the choanae, in all other examples of the species the groups are similar in position to that described, although their degree of development differs in a few individuals, one being devoid of teeth while two juveniles and one adult among the Valdivia examples have only one group. Fifty-seven per cent of the examples studied have a broad vertebral band which either extends the length of the body or is present only in the posterior half.

SECONDARY SEX CHARACTERS. Mature males have a glandular nuptial pad on the basal phalanx of each thumb; none shows any deposit of melanin. The vocal sac apparatus consists of paired subgular sacs communicating with the mouth through long slits which extend forwards from the jaw commissures.

SEX DIMORPHISM. The females are somewhat larger than the males at sexual maturity. Females with ripe ova measure 50.2-66.1 mm. (Mean = 57.6; S.E._m = 1.05; N = 15) in body length, whereas males with vocal sacs measure 43.3-65.1 mm. (Mean = 53.5; S.E._m = 2.21; N = 8). Also, the insular population from Chiloé appears to attain sexual maturity at a smaller size than the mainland and more northern populations, the males being 43-46 mm. and the females approximately 53 mm.

ECOLOGY. Data on biotopes for the Ancud material (U.B. examples) is described in Brattström & Dahl (1951) and in Schmidt (1954). These specimens were found in association with *E. roseus*.

DISTRIBUTION. Santiago de Chile to Chiloé Island.

Eupsophus taeniatus (Girard)

(Text-figs. 19-22 ; Pl. 5)

Cystignathus taeniatus Girard, 1854, p. 226 (type locality, from the neighbourhoods of Santiago, Chile).

Cystignathus taeniatus Girard, 1855, p. 207, pl. 34, figs. 8-11.

MATERIAL EXAMINED

CHILE :

Santiago : Santiago de Chile, Z.M.B. 5363.

Nuble : Chillan, B.M. 1920.1.20.1061.

Concepcion : Marsh between Concepcion and Talcahuano, N.H.M.V. 4667 (23 exs.) ; Concepcion, B.M. 1905.5.31.27-28 ; 45.5.25.60.

Cautin : Maqushue, Temuco, B.M. 1907.1.22.16-21 ; Ultra Cautin, M.C.Z. 17874.

Malleco : El Vergel, Angol, C.N.H.M. 44185.

Valdivia : L. Ranco, N.H.M.V. 9777 (16 exs.) ; La Union, N.H.M.V. 14664 (6 exs.) ; Valdivia, N.H.M.V. 4668 (15 exs.), (no number, 8 exs.), N.M.B. 1521-2, Z.M.B. 9833 (2 exs.), 5362 (3 exs.), 26120 (4 exs.), 9837, B.M. 89.12.16.174-180, 79.5.6.1-2, 1920.1.20.346 ; Desague, N.H.M.V. 4666 (24 exs.), (no number, 1 ex.) ; Panguipulli M.C.Z. 8646-51.

Llanquihue : Z.M.B. 13420-1 ; Frutillar, Z.M.B. 13406 ; Puerto Montt, Z.M.B. 13399-13400, 6619 ; Maullin, B.M. 1940.4.21.1-4 ; Casa Pangué, N.H.M.V. 4664.1 ; Puerto Toledo, Rio Maullin, Station T1 41° 30' S. 73° 20' W. U.B. No. 3 ; Estero Pichi Pilluco, E. of Puerto Montt, near sea, station L4 41° 27' S., 72° 55' W., U.B. Nos. 1-2, 10-11, 25, 60-61, 64-65, 67.

Chiloé : B.M. 1920.1.20.469, 69.5.3.56 ; Castro, B.M. 1927.5.7.9 ; Chepu, R.S.E. (1 ex.) ; NE. Ancud 41° 51' 50" S., 73° 49' 20" W., Station T6, U.B. (1 ex.).

No precise locality : N.H.M.V. 4665 (5 exs.) ; N.H.M.V. (no register number, 7 exs.) ; N.H.M.V. 4664 (Nos. 4-5) ; Z.M.B. 8368, 4711, 27041, 15874 (2 exs.), 16003, 6695 ; R.N.H.L. 4434 ; S. Chile B.M. 91.8.29.11-14.

ARGENTINE :

Rio Negro : Bariloche B.M. 1932.10.2.67 ; N.H.M.V. 4664.3 ; N.H.M.V. (no register number, 8 exs.) ; San Martin de Los Andes N.H.M.V. 4664.2.

DIAGNOSIS. Small-sized frog, slender build with rather long, narrow, flattened snout ; head slightly longer than broad ; vomerine teeth in two small, straight or

only slightly oblique groups between the middle of the choanae; first finger shorter than second; toes with a rudiment of web, not fringed but somewhat flattened; metatarsals slightly separated by webbing; proximal subarticular tubercles prominent and conical; no tarsal ridge present; skin of adults smooth or very occasionally with low, longitudinal ridges; middle ear present; mature males with granular, pigmented nuptial pads on inner palmar tubercle and on first and second fingers; single internal vocal sac with paired openings.

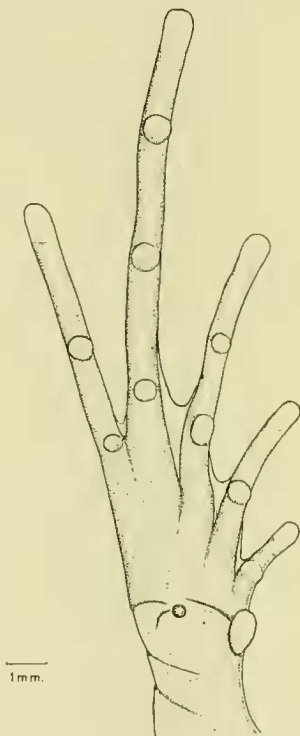


FIG. 19. *E. taematus*, U.B. No. 3. Ventral view of foot. ($\times 17.5$.)

DESCRIPTION. Adult female, Valdivia, Z.M.B. 9833. Habitus slender. Tongue rounded, its posterior half free and notched, $\frac{1}{2}$ the width of the mouth opening. Vomerine teeth in two straight groups between the middle of the circular choanae and separated from each other by a distance equal to the width of one of the choanae. Snout long, oval in dorsal view, the length $1\frac{1}{3}$ times the horizontal diameter of the eye, strongly sloping forwards and rounded at tip in profile, the upper jaw barely extending beyond lower jaw. Nares dorsal, slightly projecting, the distance between the middle of the nares less than the interorbital space which is slightly broader than

the width of the upper eyelid, their distance from the anterior borders of the eyes $1\frac{1}{2}$ times their distance from the tip of the snout. Canthus rostralis obtuse, slightly curved but not well defined; loreal region concave and strongly oblique, upper lip flaring out below; eye large and prominent, not projecting beyond the jaws in dorsal view. Middle ear apparatus fully developed; horizontal diameter of the tympanum $\frac{1}{2}$ that of eye. Well-developed, curved, glandular, supratympanic fold from behind eye to arm insertion. Short, cartilaginous omosternum with dilated tip; sternum shaped like a toadstool with pedicel directed anteriorly and calcified and posteriorly a broadly expanded cartilaginous plate without indentation, $1\frac{1}{4}$

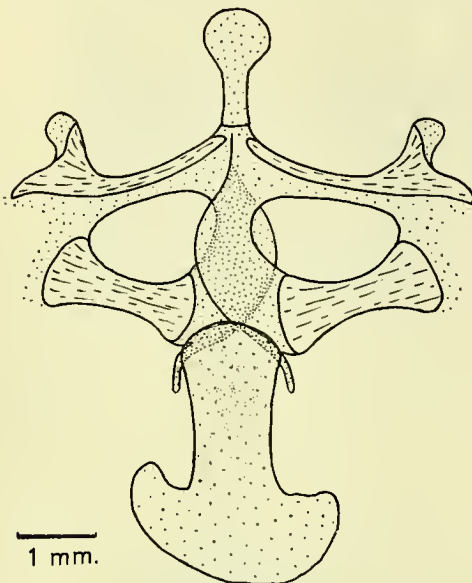
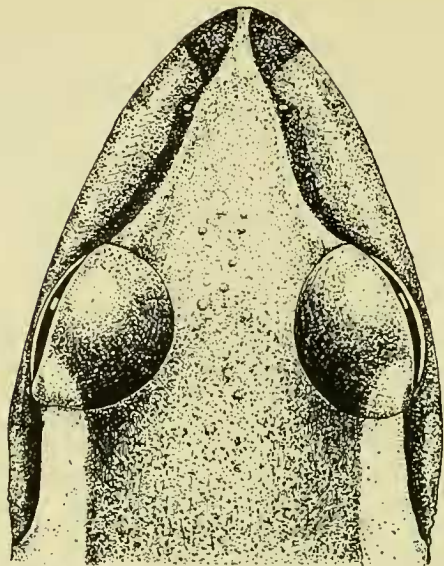
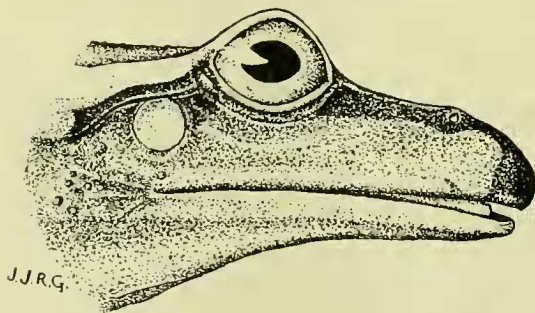


FIG. 20. *E. taeniatus*, U.B. No. 25. Ventral elements of the shoulder girdle. ($\times 17.5$.)

times the length of the epicoracoids and $2\frac{1}{2}$ times the length of the omosternum. Tibio-tarsal articulation of adpressed hind limb reaches to the anterior border of the eye. Fingers free of web, first finger shorter than second, subarticular tubercles prominent; two prominent palmar tubercles, the outer round, the inner elongate. Tips of fingers and toes rounded, with simple terminal phalanges. Toes with a rudiment of webbing and some webbing between the metatarsals, notably between the second and third, and third and fourth. An inconspicuous ridge extends along the sides of the toes which are also slightly flattened. A large, elongate, inner metatarsal tubercle with free distal edge and a very small, outer metatarsal tubercle; supernumerary metatarsal tubercles absent; subarticular tubercles well developed and somewhat conical, especially those proximal. Skin on upper parts of body quite smooth; ventral surface smooth, except for a granular area around the vent and



J.J.R.G.

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J.J.R.G.

b

FIG. 21. *E. taeniatus*. a. Dorsal view of head ; b. Lateral view of head.

on the insides of the thighs ; thighs smooth. Dark canthal line continued posteriorly as a well-defined band in the tympanic area and bounded above by a thin, light-coloured line ; longitudinal posteriorly converging dark bands on the dorsum run from behind the upper eyelid to the sacral region ; patch of bold, dark blotches on the posterior surface of the distal half of the femur ; dark spots in the inguinal area ; venter finely speckled ; limbs indistinctly cross barred ; light tarsal line from the inner metatarsal tubercle to the tibio-tarsal joint ; light band present along the upper jaw, bordered by a narrow, dark line.

Measurements :

Length of body	. 38.5 mm.
Length of tibia	. 19.5 mm.
Length of foot	. 21.8 mm.
Length of head	. 14.2 mm.
Width of head	. 13.3 mm.

VARIATION. Apart from pattern, this species is remarkably constant in its characters, especially in the position of the vomerine teeth. Normally the vomerine teeth are on a level with the middle of the choanae and out of the 174 specimens examined the only exceptions are three examples, all adults from Temuco, Llanquihue and Valdivia, which have the teeth placed farther back and slightly beyond the posterior level of the choanae. Males appear to reach sexual maturity when quite small, the smallest male in full breeding condition that was examined being 21.0 mm. whilst the largest is 35.2 mm. Females are larger than males when mature ; the largest female measures 43.5 mm.

The individuals of this species exhibit a dimorphic pattern, some being striped, as described above, while others are either immaculate or are slightly mottled and with an indication of an hour-glass pattern on the posterior interorbital area. Efforts to correlate geographical distribution, sex and age with the variation in colour pattern were unavailing. In the series examined 51% are of the striped form and 49% are immaculate or mottled. In only 4% is the throat and venter immaculate. The canthal and tympanic band is constant. It was noted that individuals which had groin marks also possessed the spots on the thigh (11 exceptions but four of these may have been due to bleaching of the specimens).

The length of foot relative to total length varies from 0.51-0.67 ($M = 0.58$; $N = 117$) and the tibia relative to total length varies from 0.43-0.57 ($M = 0.49$; $N = 117$).

SECONDARY SEX CHARACTERS. Males in the breeding condition have nuptial pads consisting of dense clusters of black spinules which cover the medio-dorsal surface of the basal phalanx of the first finger and continue as a narrow band along the median edge of the distal phalanx. Similar spinules are also present on the inner palmar tubercle and, in irregularly shaped patches, on the median edge of the second finger from its base to the proximal edge of the terminal phalanx. A median subgular vocal sac communicating with the mouth by means of paired slits is present in all males, regardless of their sexual condition.

COLORATION IN LIFE. Specimen No. 25 in the University of Bergen collection was described by the collector as having a broad chocolate-brown dorsal stripe with ventral surfaces grey-yellow with small brown spots. Throat yellow-white, without spots.

ECOLOGY. At Chepu, where one example of this species was taken, the forest is very wet and in parts where the canopy is open there is a dense underscrub. Except in the densest parts there is a ground cover of moss. The collector states that the frog was collected from the mosses of the forest floor.

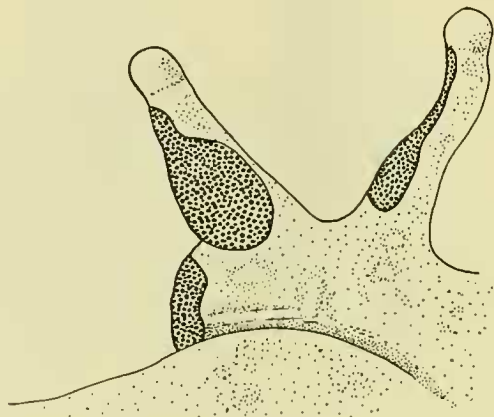


FIG. 22. *E. taeniatus*, R.N.H.L. 4434. Nuptial pads on hand of male. ($\times 17.5$.)

The biotopes and substrata relating to the University of Bergen specimens collected in Chiloé and Llanquihue have already been described by Brattström & Dahl (1951) and by Schmidt (1954).

DISTRIBUTION. Santiago to Chiloé. Also in Rio Negro Province in Argentine.

KEY TO CHILEAN SPECIES OF *Eupsophus*

- I. Middle ear apparatus absent.
 - No supernumerary metatarsal tubercles; tarsal fold present; toes distinctly webbed and fringed ***coppingeri***
- II. Middle ear apparatus present.
 1. External signs of typanum concealed by thick, glandular skin; supernumerary metatarsal tubercles present; tarsal fold present; first finger longer, or at least equal to second ***nodosus***
 2. Typanum usually visible externally; tarsal fold absent 3
 3. Vomerine teeth in two straight groups between the choanae; small, slender build, narrow snout in length $1\frac{1}{2}$ times eye diameter ***taeniatus***
 4. Vomerine teeth in two oblique groups behind the posterior border of the choanae; dorsolateral fold; usually a heel tubercle ***roseus***
 5. Vomerine teeth between the posterior halves of the choanae; no dorsolateral fold; no heel tubercle; usually a vertebral band ***vertebralis***

SUMMARY

The genus *Eupsophus* in Chile is now known to occur between latitudes 32° S. and 53° S. and is represented there by five distinct species (*coppingeri*, *nodosus*, *roseus*, *vertebralis* and *taeniatus*) which are sympatric over a large geographical area within the Valdivian Forest faunistic zone.

An examination of the tympanic cavity of existing types of Chilean *Eupsophus* has helped to clarify the status of the species and especially of *calcaratus*, *maculatus* and *coppingeri*, these three species having been described as having no tympanum; in fact, only *coppingeri* lacks a middle ear apparatus.

A new key to the component species is presented which employs the tympanum as the chief diagnostic character and each of the valid species is defined, fully described and figured. Secondary sex characters of each of the five species are also described in detail and figured.

The changes in nomenclature adopted in this paper are :

- Cacotus calcaratus* Günther = *Eupsophus roseus* D. & B.
Borborocoetes masareyi Roux = *Eupsophus roseus* D. & B.
Borborocoetes grayi Bell = *Eupsophus roseus* D. & B.
Cacotus maculatus Günther = *Eupsophus nodosus* D. & B.
Borborocoetes kriegi Müller = *Eupsophus nodosus* D. & B.

It is shown that the name *Eupsophus roseus* has been misapplied to a population of frogs that is sympatric with but distinct from *E. roseus* D. & B. This population is described and is named *Eupsophus vertebralis* sp. nov.

ADDENDUM

The author has been unable to decide whether *Cystignathus hidalgoi* Jimenez de la Espada, 1875, is distinct from the five Chilean species of *Eupsophus* now recognized, although one would have thought that the description of the species being long and exceedingly detailed and the types having come from an area in which all five valid species of *Eupsophus* occur it would have been relatively easy to establish its status.

The possibility of conspecificity with *E. coppingeri* (Günther) or with *E. nodosus* (D. & B.) can be eliminated on the grounds of the presence of a tympanum that is visible externally. *E. roseus* (D. & B.) can also be eliminated on account of the more anterior position of the vomerine teeth which in the *hidalgoi* types were in arched series between the middle of the choanae, separated on the mid-line and with their extremities touching the inner edges of the choanae. In this character *C. hidalgoi* agrees reasonably well with *E. taeniatus* (Girard) and synonymy with *taeniatus* is in fact proposed by Cei (1960). However it is difficult to agree with such a suggestion since there are strongly conflicting differences in the body proportions and skin textures of these two species.

Cystignathus hidalgoi appears to be most closely related to *E. vertebralis*. Each has a plump build, large head and a roughly semicircular contour to the maxillae,

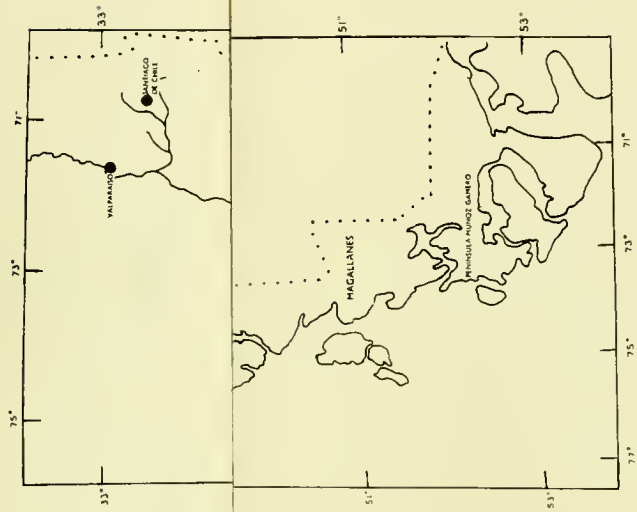
also each has a somewhat glandular and porous skin, but on the other hand *vertebralis* differs from *hidalgoi* in lacking dorsolateral bands on the body.

Unfortunately, the types of *Cystignathus hidalgoi* were destroyed during the Spanish Civil War (according to the Curator of the Herpetological Collections at the Madrid Museum).

In view of *Cystignathus hidalgoi* being unidentifiable and the types having been lost and to prevent further taxonomic confusion it might be advisable to submit to the International Commission on Zoological Nomenclature an application for suppression under the Plenary Powers of the specific name *hidalgoi* Jimenez de la Espada, 1875, as published in the combination *Cystignathus hidalgoi*.

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Map Showing Principal Collecting Localities